



Environment
Canada

Environnement
Canada

Conservation and
Protection

Conservation et
Protection

Conservation and Protection GIS Workshop Proceedings



Canada

Conservation and Protection GIS Workshop Proceedings

October 16-17, 1989

Co-Chairmen

Geoff Howell
Water Planning and Management Branch
Dartmouth, N.S.

Hugh O'Neill
Water Quality Branch
Moncton, N.B.

Recycled paper.



Think Recycling!

C&P GIS Workshop Report

Introduction

The C and P GIS Workshop was held at Queen Square in Dartmouth on October 16 and 17. The session was attended by people representing Environment Canada, Agriculture Canada, Fisheries and Oceans, Nova Scotia Environment, Nova Scotia Mines and Energy and the Tydac Corporation. A list of participants is given in Appendix 1 and the Workshop Agenda is presented in Appendix 2.

The purpose of this workshop was to provide a forum for interaction between present and potential GIS users and to focus on the future directions and applications of GIS. The first day of the workshop concentrated on an overview of the principles of GIS and also highlighted several GIS applications that have been undertaken in the Atlantic Region to date. Day 2 of the workshop was devoted to three morning working group sessions discussing the potential for GIS related projects within CEPA, wetlands and groundwater programs. The afternoon of Day 2 centred on a wrap-up of the three working groups and a round table discussion on GIS needs and the formation of GIS users group. It was intended that day 2 would identify some potential multi-sectoral GIS projects and via a users group foster interaction and co-operation amongst various agencies.

Day 1:

The workshop was opened by Geoff Howell of Water Planning and Management and the welcoming address was given by Steve Fenety, Regional Director of Inland Waters Directorate.

Tim Webster of the Tydac Corporation, Ottawa, presented an overview of GIS principles and gave an update on new developments in SPANS. This presentation discussed the principles behind various geographic projections and reviewed vector, roster and quad tree file structures. A great deal of time was devoted to the various methods of point to area conversion which was of particular interest as much of our data is point information. Mr. Webster then discussed the needs for system interfaces and indicated that a SPANS to CARIS conversion program is presently being developed. A SPANS to ARC Info interface already exists. This presentation was then wrapped up with a discussion of new SPANS features including three dimensional imaging and the conversion to OS/2 and UNIX operating systems. Mr. Webster indicated the MS-DOS versions would still be supported and that relatively inexpensive upgrades to OS/2 would be made available to present MS-DOS SPANS licensees. Conversion to OS/2 or UNIX would be highly beneficial as it makes better utilization of 386 technology and will allow faster processing as well as multi-tasking.

The afternoon session was devoted to presentations on regional GIS applications by several agencies. Abstracts of these presentations are presented in the following section.

TOXIC CHEMICAL RISK ASSESSMENT

GIS WORKSHOP - 16 OCTOBER 1989

by Hugh O'Neill

The presence of toxic organic materials in the water, bottom sediments and biota of the Atlantic Region has attracted increasing concern. Most environmental contamination is either a direct result of, or enhanced by, anthropogenic activity. It was felt that land use data could be used to identify areas of potential pesticide and contaminant input, as the presence of certain factors in an area will increase the potential for higher levels of contaminants. By identifying the areas in which these factors are present, one may infer the existence of possibly higher toxic chemical loads. Previously, however, land activity information has not been readily accessible to water resource managers and investigators. The objectives of this study were to: identify and rank areas of potential anthropogenic sources of contaminants based on land use data, to verify the resultant potential areas by use of existing Water Quality Branch data, and to illustrate how such information could be used during the design of monitoring programs and in site prioritization.

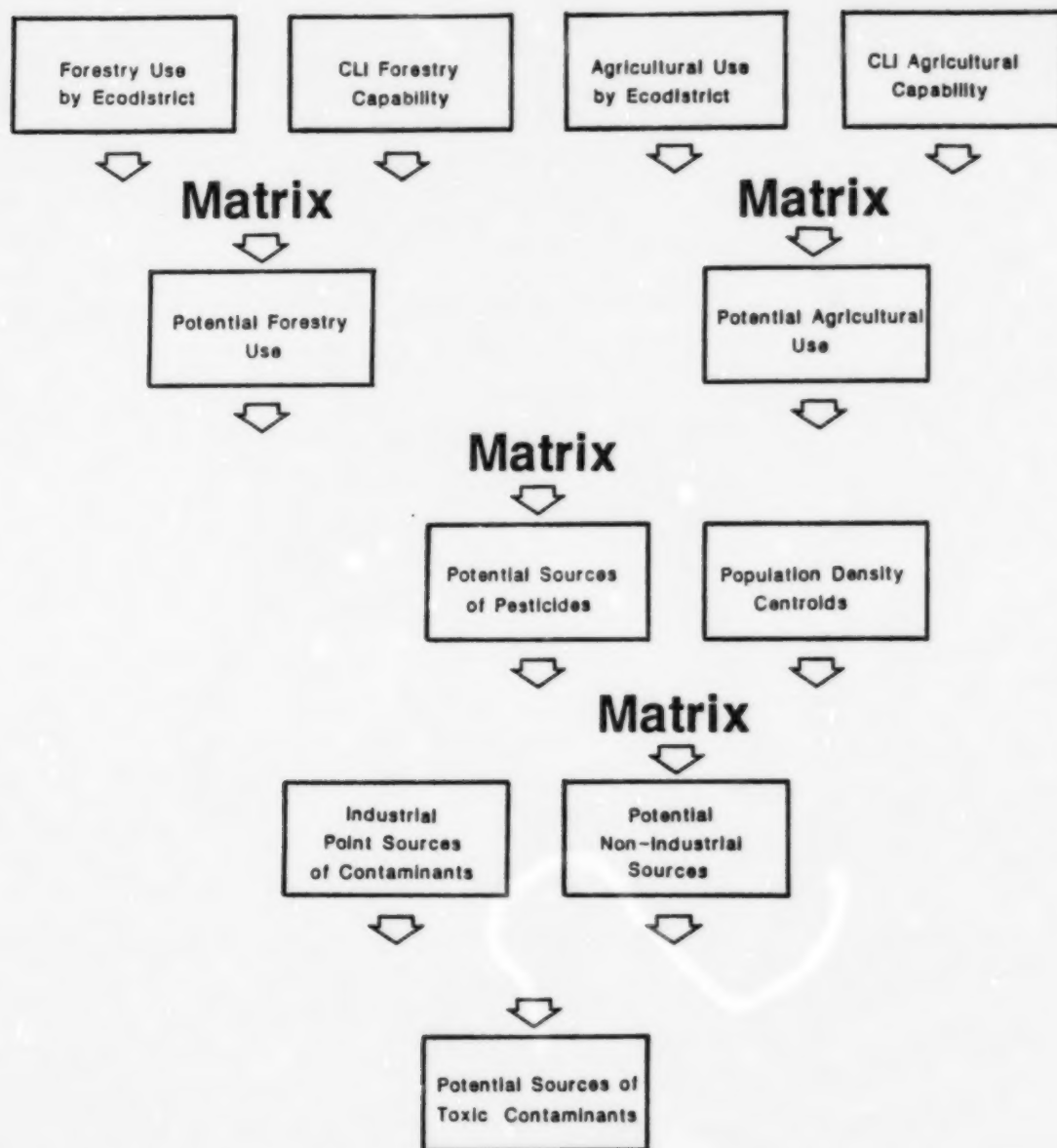
To accomplish these tasks relevant data sets were obtained from the Canada Land Data System of Environment Canada. The micro-computer based SPANS geographic information system was used to conjugate land use information such as forestry use and capability, agricultural use and capability, and population density. Two principal hypothesis maps were generated through the conjugation of land use data, industrial location and demographic data bases. The Potential Sources of Pesticides map illustrates the potential sources of agricultural pesticides while the Potential Sources of Toxics map illustrates the combination of agricultural, industrial and population factors. A relative scale was employed to rank regional contaminant potential on a "Low" to "Very High" basis. An areal analysis of the toxics map indicated that approximately 10 percent of the region fell into the two highest categories.

Water Quality Branch toxic chemical and LRTAP program data confirmed the accuracy of this map. Where Branch data indicated elevated contaminant (PAH) levels, 78 percent of these observations were in the two highest areas on the hypothesis map. Additionally, a strong correlation between the potential pesticide map and observed nutrient concentrations observed in the LRTAP data supported the validity of the hypothesis maps.

The location of abandoned waste site data expands the data base available and illustrates that GIS has application within the Canadian Environmental Protection Act (CEPA).

Such information can assist water resource managers to plan monitoring projects, prioritize site selection, and identify "hot spots". The ability to conjugate various data bases opens up areas of investigation that were previously difficult. The inclusion of geological, hydrological and biological data, land fill sites, secondary industry and atmospheric information, will facilitate greater ecosystem understanding, by allowing the modelling of various processes and inter-relationships.

Preparation of the Hypothesis Map



Pot. Sources of Toxics

wapid : pstc

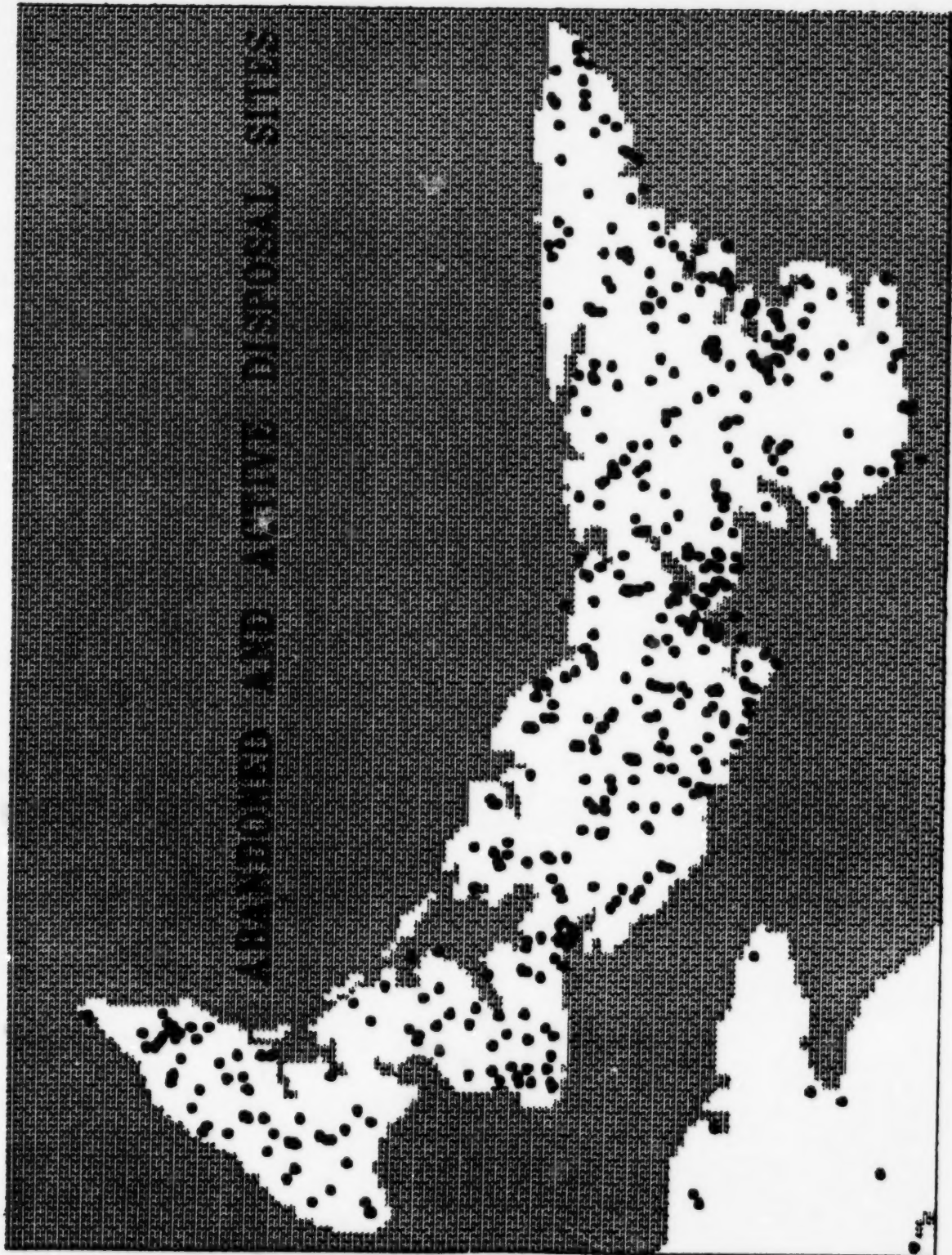


Legend

- V. High Toxic Input Potential
- High Toxic Input Potential
- Mod Toxic Input Potential
- Low Toxic Input Potential
- Unclassified
- No Data Available

200 km





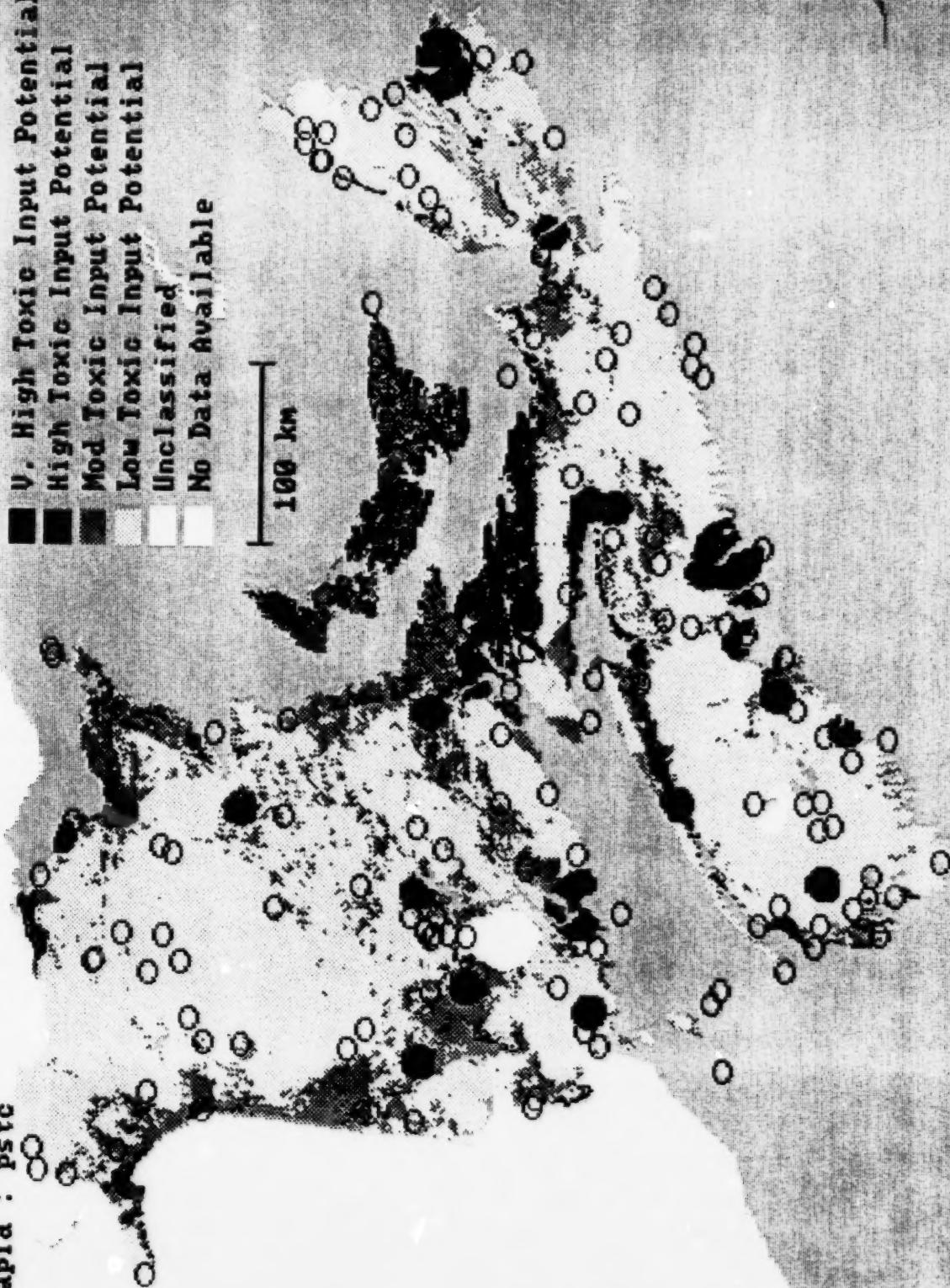
Pot. Sources of Toxics

mapid : pstc

Legend

- V. High Toxic Input Potential
- High Toxic Input Potential
- Mod Toxic Input Potential
- Low Toxic Input Potential
- Unclassified
- No Data Available

100 km



Land Use Change in the Upper Bay of Fundy Wetland
GIS Workshop - 16 October 1989
by Geoff Howell

The data employed in this land use change study was obtained from stereoscopic air photography from several flight paths flown during 1961 and 1981. The interpreted air photos were classified into 25 activities, 18 cover types and 11 modifiers and the class boundaries were scanned into CLDS and then downloaded into SPANS. All data analysis and interpretation was performed using SPANS and particularly relied on the matrix overlay and two-way areal analysis capabilities of the system. The major observations are as follows:

- 1) The dykelands have experienced significant losses in hay production and abandoned farmland (long term) and major gains in conservation areas. The uplands have also exhibited major losses in crops but the major gains are in the forestry sector.
- 2) The observed increase in the conservation sector was not derived directly from active agricultural lands but instead resulted from the conversion of abandoned agricultural areas in the dykeland and from inactive land on the uplands.
- 3) Urbanization has been largely concentrated on the uplands and has taken over approximately 13 km² of active agricultural land.
- 4) Abandoned agricultural activities are evenly distributed over the range of agricultural soil capabilities, indicating that farm abandonment is a function of many features in addition to soil fertility. However, successful agricultural areas are usually associated with high soil capabilities which indicates that fertility is a dominant factor in farm success.
- 5) Forestry is a dominant upland activity. Over the study period there has been a significant increase in active forestry as well as the areas of clearcutting.
- 6) Hay production provided the greatest revenue on the dykelands during both 1961 and 1981, even though there was a decline during the study period. Significant increases were observed in the revenues generated by sod and freshwater conservation. On the uplands, hay and pasture generated revenues dominated the 1961 economic return but by 1981 forestry was by far the most valuable land use activity.
- 7) Land capability analysis indicates that there is 153 km² (7%) of the study area which is suitable for both conservation and agricultural activities. Of this, only 20 km² was inactive during 1980 and this has a high potential for competition for future development. Once these potential areas are developed then more intensive land use conflicts between the agriculture and conservation sectors can be expected, unless methods of complementary land use development are developed.
- 8) It is necessary to adopt a multiple use approach to future development in the study area as a means of optimizing the capability of the

dykelands. This multiple use approach will not only have some direct benefits such as spreading the cost of infrastructure construction and maintenance over several sectors but will also provide the area with the flexibility to respond quickly and positively to changing market conditions.

PROCOM-2, STEREO CHANGE DETECTION MODEL (SCD)

GIS WORKSHOP - 16 October, 1989

by Dave Wilson

The PROCOM-2, SCD model located in IW's Dartmouth office has two projectors (PROCOM-2 is equipped with one projector only). The SCD model is a device with which it is possible to compare, interpret, update and transfer spatial data/information from two satellite images (at same or different scales) to a map in one step. A landsat image at a scale of 1:1,000,000 to a map at 1:10,000 is well within the capabilities of the PROCOM. The intermediate scale ranges for SPOT imagery for example, are handled by changing the lens combination mounted on the individual projects.

The two main technologies in most environmental investigations are: the remote sensing (RS) "grub" or data input step and the "glitz" or information output step; the PROCOM falls under the latter. Data acquisition is the step that requires the greater amount of resources and as such is the area where the greater potential saving is possible within a project.

With recent advances in spatial (SPOT) and spectral (LANDSAT Thematic Mapper) resolutions, revisit capability, stereo coverage and geometric correction software (for map registration): satellite imagery has become a 'real option' for operational use by resource managers. 'Real' as compared to the previous generations of satellite sensing systems such as LANDSAT Multispectral scanner. With these improvements (such as the increase in spatial resolution from 79 metre LANDSAT MSS to 10 metre SPOT panchromatic), satellite image products in the form of film transparencies can now be used to advantage over digital tape formats. The PROCOM fills the gap between the interpreted satellite image and a base map or a GIS such as SPANS for creation of a new or the updating of an existing data base.

Specific advantages of film image format include:

1. A reduction in the price of the film over the digital products,
2. A greater simplicity in the techniques needed to process the imagery,
3. A requirement for less costly processing equipment,
4. And an image format on which proven air photo interpretation techniques can be employed.

Several IW studies were described as examples of applications employing the PROCOM. Some involved joint ventures with the CNES (French Space Agency), SPOT Image Corp., Canada Centre for Remote Sensing, N.S. Dept. Municipal Affairs, L.R.I.S., Amherst and Atlantic Canada Airborne Sensing Inc., Debert. The initial work was done on instruments located in EC Hull, the manufacturer site in Ottawa and C.O.G.S. in Lawrencetown.

Projects include:

1. A practical means of evaluating the applicability of the new SPOT satellite to IW programs,
2. Detection of individual houses in the Truro area with the updating of the N.S. Settlement Survey as the goal,
3. PEI soil erosion potential hazard mapping from imagery,
4. An Atlantic land use overview and a 20 year CLI land use update

for input to SPANS; resulting data sets could provide digital base for other EC programs such as CEPA,

5. Procom was used to support the first use of SPOT imagery to update CLI land use data base in SPANS.

A question that is now under discussion is when to digitize interpreted image data. While the PROCOM deals with analogue (film) products, a digital data base in a GIS environment offers several advantages over hard copy only. A digitizing tablet is an available option for the PROCOM.

In conclusion, the PROCOM-2 SCD transfer device fills an existing gap in the environmental monitoring process. It represents a cost effective, relatively simple and available device for obtaining resource related information. The image transparency offers a readily accessible source of visual data for future EC needs.

FMG Project: An Overview
GIS Workshop - 16 October 1989
by Wayne Barchard

There are many different and often opposing uses of the coastal and marine environment, such as fishing, aquaculture, waste disposal and ocean dumping, recreation and tourism, hydrocarbon exploration and extraction, ocean mining to name but a few. With increasing demands upon coastal and ocean space, including the sea surface, the water column and the sea bed, comes an increase in the frequency and intensity of conflicts. Such conflicts result not only from the often opposing objectives of environmental conservation and development, but also as a result of competition between resource-users themselves. These conflicts are usually inherently spatial in nature and often reflect the cumulative environmental impacts of development, requiring an area-wide or regional approach to environmental and resource management rather than the more traditional site-specific approach.

Before any fair resolution of these conflicts can be achieved, a comprehensive knowledge of the resources and uses of coastal and marine environments is required. This information must then be placed in the hands of decision-makers in a usable form so that they can intelligently address the interests of the various stakeholders. Unfortunately, such comprehensive information is seldom readily available and rarely in the possession of decision-makers. Most often, the bulk of the data is held and controlled by individuals in separate and often widely different departments at all the levels of government. Also, the formats of these data sources range from written records to a variety of electronic systems.

In an unprecedented pilot study, the Bay of Fundy/Gulf of Maine/Georges Bank Information and Mapping Project (known as the FMG Project for short) is attempting to integrate a wide selection of data bases and to allow for information derived from those data to be displayed in map form (i.e. spatially). In compiling the FMG System, information from a wide variety of sources from both the United States and Canada have been utilised. In some cases digital data bases have been incorporated directly into the FMG System, while in others maps and reports form the basis of information.

The FMG Project is a joint venture between the Department of Geography at Saint Mary's University, the School for Resource and Environmental Studies at Dalhousie University, and the Land Registration and Information Service (LRIS) at Amherst, N.S. The project is funded through the Department of Supply and Services (DSS) Unsolicited Proposal programme. The \$422,000 grant includes contributions from five federal government departments (including Environment Canada, which is the lead agency, and Fisheries and Oceans Canada), the Council of Maritime Premiers and Texaco Canada Resources Ltd.

The information is being mapped at a scale of 1:2 million. The maps and text will cover physical, ecological and socio-economic characteristics of the region, including such topics as bathymetry, bedrock and surficial geology, bottom sediments, physical and chemical oceanography (e.g. tidal range and phase, currents, water temperature, salinity and density), fish species distributions, political and administrative boundaries, population and land-use characteristics. Also, critical resource and environmental management issues will be addressed, such as coastal and marine pollution, ocean dumping, acid rain and aquaculture development. In the GIS, each map

will be backed up by data files which will include numerical data from which the map has been derived (where appropriate), additional data of relevance to the map topic, and a detailed identification of all the sources (called an audit trail) used to compile the map and accompanying text.

The FMG Information System is being developed using the CARIS GIS software, which is produced by Universal Systems Ltd. in Fredericton, N.B.. CARIS is a mainframe GIS, requiring a mini-VAX computer, and is similar to other systems on the market, such as ARC-INFO, SPANS and STRINGS. However, all these systems are difficult to operate and require technical skills and expensive hardware that are usually beyond the means of decision-makers, especially in this age of user-friendly micro-computers. To overcome this, the FMG System will also be available on a PC software package called Geo-Mate (see below). Developed by LRIS, Geo-Mate will allow the user to access the FMG data base, display maps and undertake relatively simple routines such as overlaying maps, undertaking data searches, etc.. Geo-Mate does not give full GIS capabilities, but for many researchers and decision-makers such complex analytical operations are not required.

The FMG System is scheduled for completion by the end of March 1990. The digital data-base is designed primarily for use by resource managers, environmental conservation and protection agencies, and by scientists. The system also has educational and briefing applications for universities, schools, politicians and the general public. However, to meet the needs of these sections of the community more fully, it might be appropriate to consider the production of a hard-copy and/or electronic atlas.

GEOGRAPHIC INFORMATION SYSTEMS**ENVIRONMENT CANADA - PARKS SERVICE - ATLANTIC REGION
GIS Workshop - 16 October 1989**

by Larry Brown

Environment Canada's Parks Service (PS) is mandated to protect, preserve and present Canada's natural and cultural heritage for present and future generations.

To carry out this mandate, knowledge of and easy access to natural and cultural resources information for environmental impact analysis, resource and park management planning is of utmost importance. In the Parks Service, the Natural Resource Conservation Section (NRC) is responsible for developing and keeping current the natural resource databank information.

Geodetic, biophysical, cultural and infrastructure databases consisting of 1000 to 10,000 polygon as well as point data sets at scales ranging from 1:12,500 to 1:125,000 have been developed for each park and a number of historic sites.

BACKGROUND:

Originally, electronic databases were developed on the Canada Land Data System (CLDS) and Canada Soils Information System (CANSIS) mainframe geographic information systems (GIS). Analysis of park resources information databanks was carried out on a shared communications network.

With increasing user demand, the high costs of mainframe operation and the development of personal computer (PC) GIS software packages; the Parks Service opted for the establishment of independent PC stations to be set-up in individual parks and regional offices.

After evaluating GIS software packages available in the early eighties, TYDAC's Spatial Analysis System (SPANS) was selected.

To date, there are 18 systems in both parks and regional offices nation wide. In Atlantic Region parks, six out of nine stations have been set-up and the remaining three are scheduled for completion within the next two years.

PRESENT AND FUTURE GIS ACTIVITIES:

Establishing independent GIS systems for all parks is the major PS - Atlantic Region thrust for the moment. Accompanying this goal are the following related activities:

- download all mainframe databases to a SPANS compatible format;
- training workshops to develop in-house expertise in electronic database manipulation and analysis;
- develop pilot projects for each station through co-operative agreements with universities and technical institutions;
- establish a full time resource data manager position at the regional level;
- collaborate in the development of an environmental impact analysis expert system which will interface with GIS databanks.

WHAT'S IN STORE FOR THE NEAR FUTURE:

GIS, as in any other new analytical tool, will need dedicated person resources to be able to adequately and efficiently use the potential it has to offer. On a project by project basis, the Parks Service - Atlantic Region in cooperation with government and academic organizations is now in a position to provide access to and analysis development of park resources information for park planning and development.

Appendices 3 to 5 cover the status of GIS of the Atlantic Region's Natural Resource Conservation Sections, a cost-benefit analysis of selected resource conservation GIS projects carried out by the Natural Resources Branch, Parks Service in Hull and a list of PS contacts for the region.

Day 2.

The workshop attendees were divided into three working groups as given in Table 1. Each group was tasked with addressing a series of questions (Table 2) within the context of the workshop topic. The workshop reports are presented below.

Workshop A - CEPA

Chairperson - Colin Duerden
Rapporteur - Hugh O'Neill

The first hour of this session was spent in discussion of various GIS, CEPA and data base topics. Some general statements were derived and will be summarized at the end. Discussion focused upon each part of CEPA and what GIS applications were possible, and what data bases might be required as follows:

Part I - Monitoring - GIS technology could be used to simplify via modelling, complex interactions and to identify data inadequacies.

SOE - It was felt that there were several possibilities within SOE reporting, both as pictorial representations and data summaries.

Part II - Toxic Substances - Consensus indicated that most of the data base applications would fall into this area due to the breadth of the topic and that several could be GIS formatted. These included:

- PCB Inventories
- PSL Data (presence, absence, producers)
- Hazardous Waste Sites
- Hazardous Waste Producers
- Spills (location, quantity, type)
- Environmental Atlas Data
- Land Use Overview (Land Sat)
- Habitat (Fisheries, CWS)
- Watersheds
- Industrial Point Sources
- External data (Universities, NGO's, etc.)
- Mussel Watch data

It was briefly mentioned that EP (Contaminants and Assessments and IWD (Water Quality) had undertaken a data base/GIS project with land disposal sites and that this report was in draft. This project could influence future endeavours.

Part III - Nutrients - Because most of this work is product information, it is not directly applicable to GIS but would be suitable for data base storage.

Part IV - Federal Activities:

- An inventory of all Federal properties, environmental concerns.
- Infilling projects.

Part V - Air

- Plume modelling within SPANS would be of use in this area with the caveat that AES would have several atmospheric models available.
- Point Source Inventories

Part VI - Ocean Dumping: - Ocean dumping has been geo-coded due to the nature of working in the open sea. As a consequence much of their data is GIS compatible.

- The value of interfacing with FMG and ICOIN were mentioned under ocean dumping.
- Permit locations along with physio-chemical characteristics information exists.
- Coastal Zone Mapping.

RECOMMENDATIONS

As a result of the discussions that took place in the CEPA work group, several common themes arose.

- 1) It was recognized that geo-coding should occur on all projects so that data would be GIS compatible. This requirement should be extended to external sources of data.
- 2) The need for an "audit trail" to ensure the validity of data was also frequently mentioned.
- 3) Because several GIS systems are in use in the Region, there is a need for interfaces so that data may be easily exchanged.
- 4) A working group should be formed to exchange information (users group).
- 5) It was also brought out that those who made presentations of SPANS applications also had some computer support. There was a general feeling that in order for other users to be up and running, some computer science support would be required.

Workshop B - Wetlands

Chairperson - Liz Langley
Rapporteur - Wayne Barchard

The wetlands workshop had a good representation of individuals from various disciplines and attempted to address each of the proposed questions.

Question 1: There are several wetland related projects that could be undertaken within the confines of a GIS system. In support of a national policy for management of wetlands a GIS based wetlands designation scheme

could also be developed that would incorporate values for habitat, recreation, flood plains, shoreline protection, water quality, waste treatment and groundwater. In addition, there were several potential GIS applications identified for coastal zone development management, fish habitat management and climate change responses. More specifically, the working group felt that GIS could be useful for assessing status and trends in the wetland resource, classifying wetland types and values, performing an assessment of sustainability and developing forecasting capabilities with various wetland models.

Discussion on the relevance of GIS focused on the need to make an intimate connection with the manager's needs and thus GIS output should be manager friendly as well as user friendly. There is a need to promote the availability of GIS and it was felt that this could be best achieved by a users group. In addition, it is important to document the existing databases and it was suggested that the Environmental Protection Service database inventory would make a useful starting point.

Question 2: The discussion on the availability of databases noted that existing information is in diverse forms (paper maps, air photos, data files, etc.) and is often not georeferenced. Specific needs have a common data/information requirement (eg. discharge, water quality, slope, soil type, vegetation type, etc.) but generally need specific levels of data aggregation. There is a need to design a database that will be able to suit all of these requirements. It was suggested that the tertiary watershed designation should be considered as a prime aggregation unit as it is environmentally relevant and it solves problems associated with crossing social and political boundaries.

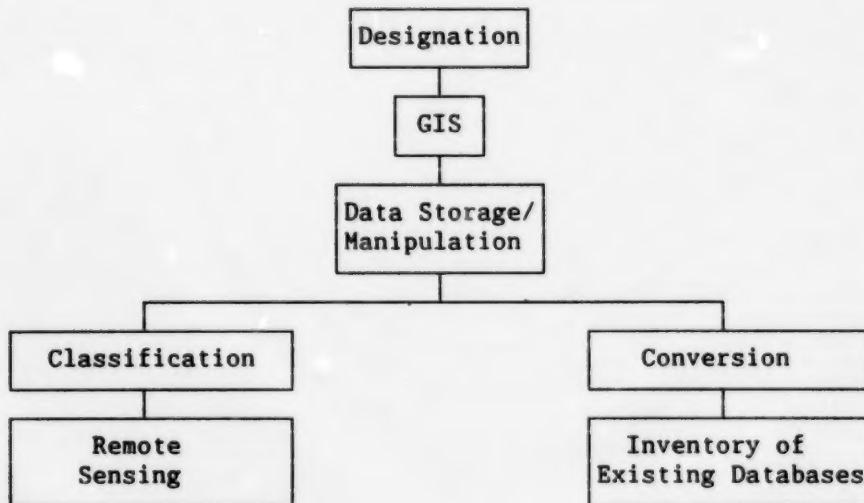
With respect to database compatibility, it was felt that these difficulties are largely a function of how much effort is put into developing interfaces. In fact, it appears that database compatibility is being less and less of a problem. As databases will continue to be maintained separately by specific managers it is essential that standardized networking protocols are developed. A word of caution was expressed that establishing adequate audit and quality control protocols will become more important as common users begin using data from other sources.

Question #3: It was not known how many GIS applications have previously focused on wetlands. It was felt that known, existing or planned GIS functions should be a responsibility of a GIS users group, either through a newsletter or an electronic bulletin board.

Question #4: The GIS capabilities that are suitable for wetland studies include the manipulation of large datasets, modelling both within the GIS environment and also import/export to other modelling environments, remote sensing and networking. Some GIS's are better at one function than others. For example CARIS seems to excel at data archiving whereas SPANS has powerful modelling capabilities. It was also noted that GIS is a powerful reactive tool for crisis management. For example, response to an oil spill requires control data management that will facilitate information manipulation with import/export capabilities to and from remote (on scene) locations. In order for this to be feasible it will be necessary to reduce the front end component of any task.

Question #5: Figure 1 gives a conceptual framework for the design of GIS based national wetlands designation program. This will include incorporation of various databases, of both point and thematic map type. These databases can include such components as water chemistry, biological diversity indicators (eg. Goulet score), population density, etc.

Figure 1



Concluding Points:

1. GIS is not a database but needs easy networking to databases.
2. There is a need for good database and information management.
3. There is a need for communication between GIS users (ie. networking, standards, protocols and a knowledge of what presently exists).

Editor's Note: This working group has focused on the necessity of establishing standardized databases built on consistent levels of aggregation. Although this is one approach, it is also feasible to allow some flexibility in individual database structures and focus on the establishment of various interfaces. With respect to data aggregation level, this is a consideration that can be resolved within the GIS environment and probably should not be standardized within the database structure.

Workshop C - Groundwater

Chairperson - Bill Brimley
Rapporteur - J.G. Deveau

The working group recognized that there are several possible GIS applications for groundwater studies including contamination risk assessment, delineation of well protection zones and the influence of land use practises on groundwater quantity and quality. It was decided that for the rest of the workshop that the group would focus on the requirements for developing a groundwater risk model. In order to achieve this application it would be

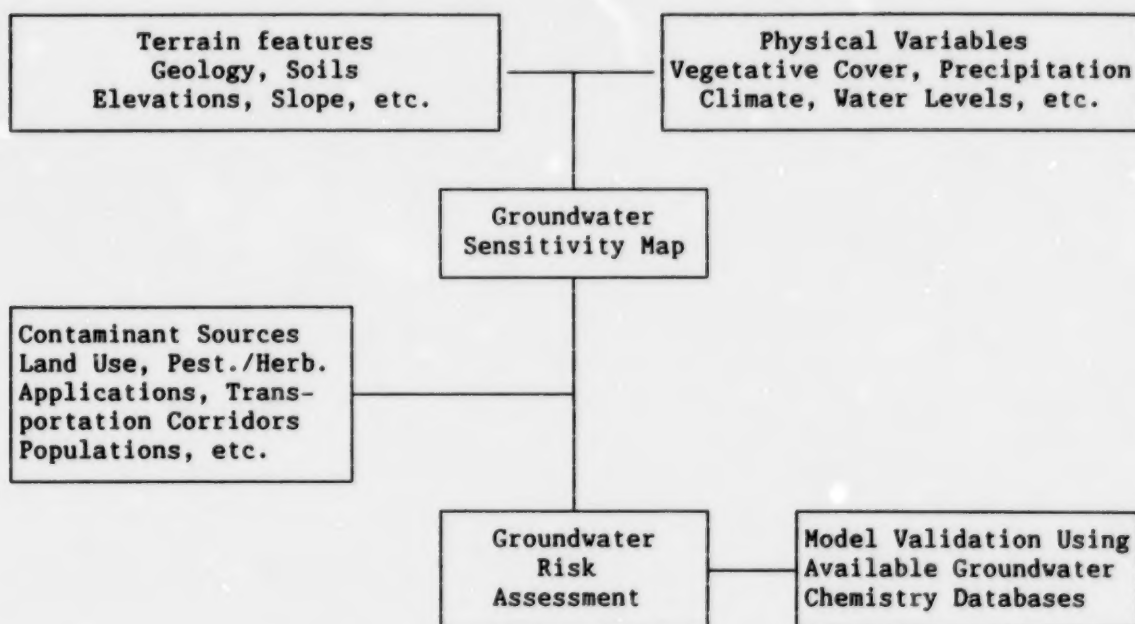
necessary to incorporate numerous databases including water chemistry, soils, geology, land use, elevation, water level data, meteorological data, population density, pesticide application surveys and waste disposal sites etc. It was realized that most of these databases are presently available but it would be necessary to link up with many different agencies. Given the diverse nature of many of these databases it is highly likely that there will be considerable effort expended in developing suitable GIS interfaces.

With respect to what present activities or portions of this application have been previously attempted it was noted that some of the New England states have used GIS to map groundwater contamination zones. Locally, PEI has implemented a groundwater inventory on CARIS while SPANS has been used for selected hydrogeological studies at Sheffield Farm in Nova Scotia.

It was felt that the strong modelling and overlay capabilities of GIS would be useful in developing the groundwater vulnerability assessment. Once completed, this would facilitate groundwater sampling network design and could also be used to identify problem areas. Some discussion was devoted to the potential of this GIS to react to emergencies such as spills of hazardous chemicals and to determine the potential influence that these spills may have on the groundwater resource.

Figure 1 presents a conceptual framework that could be used to develop a groundwater risk assessment. The first step is to determine the terrain vulnerability and would require the incorporation of data on geology, soils and slope. The next step would be to then incorporate various physical features into the model as a means of mimicing the hydrologic system (e.g. vegetative cover, precipitation, climate water levels). This would then result in a groundwater sensitivity map. The final step in this analysis would be to incorporate the potential sources of contaminant loading. This would include both areal and point source data such as pesticide/herbicide applications, landfill sites and transportation corridors, etc. The resultant risk assessment map could then be validated using historic groundwater chemistry records.

Figure 1: Groundwater Risk Assessment Design Criteria



During this working session a number of general comments were repeated on several occasions. It was felt that it was necessary to increase the number of people involved in GIS applications in order to maximize both technical expertise and availability of diverse data sets. It was cautioned that as the number of data sets increases, so will the need for enhanced quality control and assurance techniques. There was general agreement that there was a need for an in depth inventory of existing databases and that efforts should be made to ensure that all databases are GIS compatible. It was felt that this is a task that could be undertaken by the GIS Users Group.

Roundtable Discussion

There was general agreement that GIS is a valuable analytical and display tool and that there is no shortage of potential applications. There seemed to be strong support for the use of GIS in CEPA, wetlands, wildlife studies and SOE reporting. It was once again emphasized that it was necessary to establish a set of database input standards to ensure not only GIS compatibility but also to ensure adequate quality control/assurance. In addition, it was noted that we should not focus on any particular GIS but instead we should use the system that is best suited for the particular application.

The discussion quickly led into the subject of the formation of a regional GIS Users Group. This idea received strong support from nearly all of the workshop attendees and it was decided that we should proceed with the establishment of the users group. However, there was considerable discussion about what this group should do, how it should be structured and reporting

relationships with other EDP and Geomatics Committees. There was a strong feeling that this group should be charged with establishing and maintaining a comprehensive inventory of available databases as well as providing a liaison between GIS users and those with no GIS experience. In addition, the regional users group should report to the regional EDP committee as well as the National Geomatics Working Group. As discussion about the users group continued it became readily apparent that in order for this group to adequately lead and develop the regional GIS applications it would be necessary to have strong support from management. It was recommended that a GIS briefing session should be put together for presentation to senior management with the intent of achieving resource commitments to ensure our continuing role in the use and development of these systems. It was agreed that the users group should develop a proposal and initiate a pilot study that would showcase the strong analytical and integrative capabilities of GIS. The proposed terms of reference (Table 3) for the users group were then reviewed and it was generally agreed that most of the discussion points were covered by the stated TOR's. The workshop then closed with a request for interested parties to serve on the users group. A core group was established and was made up of Geoff Howell (IWD), Hugh O'Neill (IWD), Chris Roberts (EP), Les Rutherford (EP), Wayne Barchard (EP) and Shane O'Neil (DFO).

WETLANDS WORKSHOP

4TH FLOOR

Chair: Liz Langley

W. Barchard
P. Eaton
S. O'Neill
M. Sheeran
P. Schwartz
T. Turner
D. Lockerbie
C. McKinnon

CEPA WORKSHOP

5TH FLOOR

Chair: Colin Duerden

L. Rutherford
D. Busby
H. O'Neill
C. Roberts
B. Jeffrey
P. Johnson
A. Vormans
D. Wilson
O. Vaidya
A. McIver

GROUND WATER WORKSHOP

15TH FLOOR

Chair: Bill Brimley

R. Pol
D. Conrod
J.G. Deveau
J. Gibb
G. Howell
F. Boner
T. Gouth

Table 2: Workshop Questions

1. What Questions or Issues within this topic could be addressed under a GIS Framework?
2. What Data Bases are necessary for the application(s). Are they available and GIS compatible?
3. Has part or all of this GIS application been attempted and/or completed previously?
4. What GIS capabilities are best suited for this study?
5. Design a conceptual GIS Framework for this study.

Table 3: GIS Users Group Proposed Terms of Reference

1. Promote the use of GIS as a tool to foster integrated and co-operative projects between various Federal Branches, Directorates and Departments within the region.
2. To provide assistance and advice to all project officers, scientists and managers within the region who have potential GIS applications.
3. To ensure consistency within the region of future GIS applications and system developments and to provide a liaison with manufacturers and other non-federal users.
4. To enhance communication amongst various GIS users to share knowledge on software and hardware development and capabilities.
5. To provide advice to management on the future enhancement of GIS capabilities within the region.
6. Provide information and advice on GIS to the various departmental EDP Co-ordinating Committees.

Appendix 1. List of Workshop Participants

<u>Name</u>	<u>Address</u>
Les Rutherford	EP, Contaminants & Assessments Branch, Dartmouth
Colin MacKinnon	Habitat Program, CWS, Sackville
Dan Busby	CWS, Sackville, N.B.
Dave McBride	WRB, Dartmouth, N.S.
R.A. Pol	WRB, Dartmouth, N.S.
Hugh O'Neill	WQB, Moncton
Billie Beattie	AES, Bedford
David Lockerbie	WQB, Moncton
Ken Webb	Land Resource Research Centre, Ag. Can., Truro
Liz Langley	IWD, Dartmouth
Bill Brimley	IWD, Dartmouth
D.W. Conrod	IWD, Dartmouth
Chris Roberts	EP/Env. Control Br., Dartmouth
Wayne Barchard	EP/Marine Environment Br., Dartmouth
John Clarke	IWD, WRB Dartmouth
Jean-Guy Deveau	IWD, WRB Dartmouth
Roger Percy	EED, EP-Dartmouth
Barry Jeffrey	EP, St. John's, Nfld.
John Gibb	IWD, WPM, Dartmouth
Peter Johnson	EP, EQ Div., Dartmouth
Peter Eaton	EP, Contaminants & Ass. Br., Dartmouth
Graham MacKay	LRIS, Summerside, P.E.I.
Alan McIver	EP Marine Asst Division, Dartmouth
Albert Vromans	DFO Moncton, N.B.
Shane F. O'Neil	DFR - FWA Halifax
Marc Sheeran	EPF - 15th floor, Queen Square, Dartmouth
Geoff Howell	IWD - Dartmouth
Paul Schwartz	N.S. Dept. of Environment
Fred J. Boner	N.S. Dept. of Mines and Energy
Tom Guoth	TUNS
Peter Rogers	N.S. Mines and Energy
Tony Turner	DOE - Sustainable Development Branch - Ottawa
Tim Webster	Tydac Corporation, Ottawa
Dave Wilson	IWD, Dartmouth
Colin Duerden	EP, Dartmouth
Steve Fenety	IWD, Dartmouth
Larry Brown	Parks, Halifax

Appendix 2: C&P GIS Workshop Agenda

DATE: October 16 and 17

TIME: 0900 hours

PLACE: Environment Canada
5th Floor Boardroom
Queen Square
45 Alderney Drive
Dartmouth, Nova Scotia

DAY 1 - October 16

0900 - 0915	Introduction	S. Fenety, Regional Director IWD
0915 - 1000	Introduction to GIS	T. Webster, Tydac Corporation
1000 - 1030	Coffee	
1030 - 1130	SPANS - Capabilities, Applications & Interfaces	- T. Webster
1130 - 1200	Open Forum on SPANS - Now and in the Future	- T. Webster
1200 - 1300	Lunch	
1300 - 1320	Toxic Chemical Risk Assessment	- H. O'Neill
1320 - 1340	Tantramar Land Use Change	- G. Howell
1340 - 1400	Parks Canada Applications	- L. Brown
1400 - 1420	FMG Project	- W. Barchard
1420 - 1430	ICOIN Video	
1430 - 1500	Coffee	
1500 - 1520	Fisheries and Oceans Applications	- A. Vromans/ J. Legault
1520 - 1540	Procom Optical Transfer Device	- D. Wilson

DAY 2 - October 17

0900 - 0930 Workshop Organization

0930 - 1200 Workshop A - CEPA and GIS 5th Floor Boardroom

Workshop B - Wetlands and GIS 4th Floor Boardroom

Workshop C - Groundwater and GIS 15th Floor Boardroom

1200 - 1300 Lunch

1300 - 1400 Workshop Reports

1400 - 1500 Round Table Discussion - Data Needs & Interfaces

Potential GIS Applications

1500 - 1530 Coffee

1530 - 1630 GIS Users Group - Terms of Reference

Structure

Appendix 3

PARKS SERVICE GIS STATUS IN THE ATLANTIC REGION

The following is an abridged version of the Parks Service - Atlantic Region - Natural Resource Conservation GIS Informatics Plan for the period 1989 to 1992:

. systems completed to date (1989/10/30)

(includes hardware and SPANS software acquisition)

ARO-NRC
Kouchibouguac
Kejimikujik (1)
Cape Breton Highlands
Terra Nova (2)

. systems to be completed

(purchase of either SPANS software (S) and/or hardware (H), database development (DD) or database download to SPANS (D)).

Gros Morne	/ S H	1990/91 (2)
FoL	/ S H DD	1990/91 (3)
Fundy	/ S H D	
PEI	/ S DD	1990/91
Fundy	/ S H D	1990/92 (4)

- (1) Seaside Adjunct, the Atlantic Coastal Plain component of Kejimikujik National Park, SPANS database created in 1988/89, main park database scheduled to be digitised in 1991/92.
- (2) Mainframe databases to be downloaded to SPANS in 1989/90.
- (3) Database development 1989/90.
- (4) Mainframe database to be downloaded to SPANS in 1990/91.

1990/91

Gros Morne National Park is scheduled for a Park Management Plan review in 1991/92 and will be embarking on a domestic wood harvesting review and update in 1990-91. The SPANS GIS database will be used in the completion of inventories and in analysis of ongoing and upcoming sectorial studies such as the park vegetation management plan, oversnow vehicle plan, etc.

PBI National Park will purchase SPANS and develop the park and park crownlands electronic database in 1990-91. This database will become part of an Environment Canada (EC) pilot project to develop an island wide environmental database system.

Fortress of Louisbourg National Historic Park is scheduled for the Park Management Planning process in 1990/91. An essential part of the planning process is the Resource Description and Analysis component for which a SPANS GIS has been requested. The system will serve as an analysis tool for natural and cultural resource data manipulation, in the production of the final report and in the development and verification of planning scenarios.

1991/92

Fundy National Park will be using the GIS station in the update of its vegetation cover data and in the development of environmental impact scenarios for "peripheral activities"; the #1 natural resource conservation park priority.

Government and private organizations neighbouring the park boundary involved in land use activities are presently equipped with GIS stations.

Appendix 4:

COST-BENEFIT ANALYSIS OF NATIONAL PARKS DIRECTORATE
SPANS GIS. (1)

NORTHERN YUKON APPLICATION.

This is a headquarters project in support of the Park Management Planning and Natural Resource Management Planning Process for the Northern Yukon National Park. D. Welch, Terrain Scientist, Natural Resources Branch is responsible for chapters on Geology, Geomorphology and Soils of the park's Resource Description and Analysis.

The overall project is co-ordinated by Prairie and Northern Region Office, where there is also a SPANS system used. Costs and benefits reported here are for the headquarters component only. Further details are available upon request.

As of March, 1989, 25 map analyses were expected. The final number may vary. This summary only addresses dollar values without attempting to explain the project as such. SPANS costs are compared to estimated costs to replicate the results without the system.

Comparisons are made to use of the Canadian Geographic Information System, CGIS (as of March 1989 CGIS has become EIS, Environmental Information Systems) at Place Vincent Massey, PVM, and to manual processing, the two options otherwise available.

The high projected costs of alternatives reflects the status quo before SPANS, that many applications required to fulfil our natural resources mandate were simply not done.

SPANS COSTS

Analysis: 25 maps @ 2 hours per session
 = 50 person hours. 50 hours @
 PC04 salary plus overhead,
 50hrs * \$60 3,000.00

(hourly rate matches daily
 consultant fee for professional
 services, about \$450.00 per day)

Map design, printing: 25 @ 1 hr. each * \$60 1,500.00

Training for one person 950.00

TOTAL SPANS COSTS 5,450.00

CGIS ALTERNATIVE.

Based on a previous similar project for Fundy National Park, CGIS needed an average of three interactive sessions per map output to get similar results.

25 maps @ 6 hours each: 150 hrs * \$60 9,000.00

CGIS operator support:
 150 hrs * \$20 3,000.00

Map design, printing:
 25 * 1 hr @ \$20 + materials 750.00

Commuting PHQ to PVM:
 75 * 1 hr. return @ \$30/hr. 2,250.00

TOTAL CGIS ALTERNATIVE 15,000.00

MANUAL ALTERNATIVE

For each map analysis, based on one professional day to write up data selection criteria, map design specifications, and give general supervision to a technician, and 5 technician days to search extensive data lists, match to polygon numbers on mylar maps, calculate and reclassify map values, hand annotate maps, planimeter all map units and calculate area tabulations, and draft camera-ready versions, etc.

For maps and data tables with 600 polygons and 60 variables each, this is probable a conservative estimate. For overlay of maps with different map units, e.g. vegetation over geology, there would probably be another month of work to create a mylar registered map of intersecting polygons.

25 maps * 1 professional day + overhead:	
25 * \$450.00	11,250.00
25 maps * 5 technician day + overhead:	
25 * 5 * \$250	31,250.00
Materials	250.00
TOTAL MANUAL ALTERNATIVE	42,750.00
NET SAVINGS OVER MANUAL METHODS	38,250.00
NET SAVINGS OVER CGIS	9,550.00

LA MAURICIE APPLICATION.

Natural Resources Branch, Jean Poitevin, has completed a pilot project for the park to integrate the thematic maps of the Basic Resource Inventory into an ecosystems classification.

In this case there was no previously digitised data, and so the cost comparison is based on manual processing. \$3,000 was paid to a consultant for digitising into SPANS, \$1,400 of which came from the SPANS capital budget. 24 final output maps have been produced.

The same calculations for SPANS analysis costs are applied as for the Northern Yukon project, except that salary costs reflect a PC02 professional level.

SPANS COSTS

Analysis: 24 maps @ 2 hours per session 48 person hours. 48 hours @ PC02 salary plus overhead 48hrs * \$45	2,160.00
(hourly rate matches daily consultant fee for professional services, about \$450.00 per day)	
Map design, printing: 24 @ 1 hr. each * \$45	1,080.00
Training for one person	950.00
Digitising services	3,000.00
TOTAL SPANS COSTS	7,190.00

MANUAL COSTS

(See Northern Yukon section for explanation.)

24 maps * 1 professional day + overhead 24 * \$335	11,250.00
24 maps * 5 technician days + overhead 24*5* \$250	30,000.00
Materials	250.00
TOTAL MANUAL COSTS	41,500.00
NET SAVINGS OVER MANUAL COSTS	34,310.00

DOWNLOADING DATA BASES FROM CGIS AND AGRICULTURE CANADA

PHQ is providing a service to other present and anticipated SPANS users in National Parks by co-ordinated the downloading of existing digitised data bases from mainframe GISs in Environment Canada and Agriculture Canada.

Since each downloading requires several iterations to correct graphics and attribute data, this has turned out to be a major project. On the Parks side, D. Welch and N. Lopoukhine, Natural Resources Branch and a co-op student, Marie-Pierre Rogeau, have to date downloaded 14 major geographic coverages, but this has required up to 4 iterations per coverage.

The total of downloading "events" is therefore taken as 28. The times indicated are spent mostly in inspecting manuscript versions to set up geo-reference and attribute check values, inspecting and editing ASCII graphics files to remove certain errors, setting up and using data base files for map classification and attribute checking.

Without a SPANS station in PHQ this work would have to have been contracted out.

SPANS COSTS.

10 maps @ 12 hrs. professional time @ \$60	7,200.00
18 maps @ 12 hrs. co-op student time @ \$15	3,240.00
Training	950.00
TOTAL SPANS COSTS	11,390.00

CONTRACTING COSTS

10 events @ 12 hrs. professional time: \$60	7,200.00
18 events @ 12 hrs. technician time: \$250/8 hr. day	6,750.00
28 events @ 18 hrs. machine time: \$750/month rental for SPANS equipped hardware, assuming one 18 hr. machine session per working day = 6 weeks = 2 months	1,500.00
Contract supervision: 4 days fixed and 0.5 days per map $14 * 0.5 = 7 + 4 = 11$ total @ \$450	4,950.00
TOTAL CONTRACTING COSTS	20,400.00
NET SAVINGS OVER CONTRACTING COSTS	9,010.00

SYSTEM COSTS TO MARCH 31, 1989

Hardware, including furniture	20,821.88
Software, including operating system, utilities, etc.	5,899.25
Supplies, including paper, cartridges, ribbons, etc.	3,967.35
Maintenance, repairs, software updates, etc.	1,805.05

ESTIMATED OTHER O. & M. COSTS - SYSTEM MAINTENANCE

Based on one \$60.00 hour per week, 100 weeks, (officer's salary plus office overhead multiplier).	6,000.00
Total system costs	38,493.53
Training (7 * 950) not yet recouped through projects	6,650.00
TOTAL SPANS INVESTMENT	45,143.53

PROJECT SAVINGS.

Northern Yukon	9,550.00
La Mauricie	34,310.00
Downloading for Regions, Parks	9,010.00
TOTAL PROJECT SAVINGS	52,870.00
 NET SAVING MARCH 31, 1989	 7,726.47

OTHER COSTS PAID FROM CAPITAL

These costs are reported separately to identify project specific costs.

Digitising costs are reported against projects below.

- CanSIS services for Banff downloading	2,500.00
- DPA services for System Planning Branch	6,000.00
- Cloutier Ass. for La Mauricie (+1600 O&M)	1,400.00

Total 9,900.00

Training - various SPANS courses for 10 people	9,500.00
--	----------

Travel - to WRO for regional GIS meeting (re WRO project)	1,370.00
---	----------

TOTAL OF OTHER EXPENDITURES FROM CAPITAL	20,670.00
---	------------------

- (1) The above cost-benefit analysis examples were documented by David Welch, Terrain Scientist with the Natural Resources Branch, Park Service, Environment Canada in Hull. David is presently on sabbatical leave and will be returning in August 1990. However, any questions concerning the above information can be directed to:

Larry Brown
NRMP Coordinator

and/or

D.M. Welch, PH.D.
Terrain Scientist

Parks Service
Atlantic Region
Historic Properties,
Upper Water Street,
Halifax, Nova Scotia
B3J 1S9

Natural Resource Branch
National Parks Directorate
Canadian Parks Service
Environment Canada
Ottawa, Ontario
K1A 0H3

(902) 426-2063
FAX: (902) 426-7012

(819) 994-5533
Fax: (819) 997-2443

Appendix 5

GIS-SPANS USERS/CONTACT LISTParks Service - Atlantic Region

Larry Brown
 NRMP Coordinator
 Parks Service - Atlantic Region
 Historic Properties
 Upper Water Street
 Halifax, Nova Scotia
 B3J 1S9
 (902) 426-2063
 FAX: (902) 426-7012
 DOTS: BROWNL AT A1 AT PKSARO

Al Gibbs, Chief Park Warden,
 Cape Breton Highlands N. P.,
 Canadian Parks Service,
 Ingonish Beach, Nova Scotia.
 BOC 1LO
 FAX: (902) 285-2866
 DOTS: GIBBSA AT A1 AT PKSCBH

Paul Caines, Chief Park Warden,
 Gros Morne N. P.,
 Canadian Parks Service,
 P. O. Box 130,
 Rocky Harbour,
 Bonne Bay, Newfoundland.
 AOK 4NO
 FAX: (709) 458-2059
 DOTS: HOWELLI AT A1 AT PKSGM

Jordan Wentzell, Chief Park Warden,
 Kejimikujik N. P.,
 Canadian Parks Service,
 P. O. Box 36,
 Maitland Bridge, N. S.
 BOT 1NO
 FAX: (902) 857-9981
 DOTS: WENTZELLJ AT A1 AT PKSKNP

Mike Savoie, Chief Park Warden,
 Kouchibouguac N. P.,
 Canadian Parks Service,
 Kouchibouguac,
 Kent County, New Brunswick.
 EOA 2AO
 FAX: (506) 876-4802
 DOTS: SAVOIE M AT A1 AT PKSKOU

Jim Reynolds, Chief Park Warden,
Terra Nova N. P.,
Canadian Parks Service,
Glovertown, Newfoundland.
AOG 2L0
FAX: (709) 533-2706
DOTS: REYNOLDSJ AT A1 AT PKSTN

Charlie Ristau, A/Chief Park Warden,
Prince Edward Island N. P.,
Canadian Parks Service,
P. O. Box 487,
Charlottetown, P. E. I.
C1A 7L1
FAX: (902) 566-7226
DOTS: WARDENS AT A1 AT PKSPEI

Marvin Miller, Chief Park Warden,
Fortress of Louisbourg N. H. P.
Canadian Parks Service,
P. O. Box 160,
Louisbourg, Nova Scotia.
BOA 1M0
FAX: (902) 733-2362
DOTS: MCNEILK AT A1 AT PKSLHS